REMARKS

By this amendment, claims 1, 3, 4, 8-10, 14, 25, and 32-34 are amended; claims 2, 5-6, 11-13, 26-30, 35-37 are canceled (claims 15-21 were previously canceled); new claims 38-40 are presented; and claims 1, 3-4, 7-10, 14, 22-25, 31-34 and 38-40 are pending. Claim 14 stands rejected as anticipated by *Wang*; claims 1-13 and 22-37 were rejected as obvious in view of a single reference, *Wang*. Claims 1, 14 and 25 were also objected to as requiring the conjunctive "and" at the end of the penultimate elements recited. Further examination of the application, as amended, and reconsideration of the rejections and objections are respectfully requested.

The amendment of the main claims for water quenching, the feed split between the POX reactor and the reforming exchanger, and the indirect heat exchange, finds support in dependent claims, which are canceled as appropriate. Support for the indirect heat exchange "downstream from the direct heat exchange and upstream from the reforming exchanger" in claims 3 and 25 is found *inter alia* in Fig. 2.

New claim 38 and the preamble to claim 25 have been added to emphasize that the process is operated to maximize efficient hydrogen production, support for which is found in the original specification at paragraphs [0009] and [0018] (last sentences); this is in addition to the 40:60 to 60:40 feed split also specified for

favorable hydrogen production. Support for the shift conversion steps and means in claims 14 and 39, which also increase hydrogen production and decrease CO production, is found in paragraph [0016]. Excess water in the cooled POX reactor effluent supplied to the reforming exchanger in claim 16, further indicative of maximizing hydrogen production, is found in paragraph [0015] and Table 1, or is at least implicit. It is not new matter to make explicit that which was implicit.

Although not believed to be necessary, claims 1, 14 and 25 have also been amended to address the grammatical objection by adding "and" as suggested in the office action.

By way of background, the present invention uses a reforming exchanger in combination with a POX reactor in a new hydrogen plant with improved efficiency and reduced steam export, or in an existing hydrogen plant. The hydrogen capacity can be increased by as much as 20 to 30 percent, with reduced export of steam from the hydrogen plant. See paragraph [0020]. The process includes: (a) partially oxidizing from 40 to 60% of the hydrocarbon feed with oxygen in a POX reactor; (b) cooling the POX reactor effluent with a water quench to 650° - 1000°C; (c) feeding the cooled POX reactor effluent to a reforming exchanger or 'KRES unit'; (d) passing the other 60 to 40% of the hydrocarbon feed with steam through a catalyst zone in the KRES unit; (e) mixing the KRES reactor effluent from the catalyst zone with the effluent from the POX reactor; (f) using the

admixture in the KRES unit to heat the catalyst zone; and (g) collecting the admixture from the KRES unit. The apparatus recited in claim 14 employs a means for each of these operations, plus an additional means for downstream shift conversion to convert carbon monoxide and water to carbon dioxide and additional hydrogen.

The cooling step, part (b), affirmatively recites in claims 1, 14 and 25, introducing water into the first reactor effluent as a quench fluid. Additional cooling with indirect heat exchange is emphasized in claim 3, and by cross exchange to preheat the hydrocarbon feed to the reforming exchanger in claims 4 and 25. All claims affirmatively recite cooling the POX reactor effluent to 650° to 1000°C upstream from the reforming exchanger.

In contrast, *Wang* discloses a reforming exchanger used with a POX reactor, wherein the POX effluent is quenched upstream from the reforming exchanger with carbon dioxide to maximize CO production according to the reverse shift reaction: $CO2 + H2 \Leftrightarrow CO + H2O$. See paragraphs [0032] and [0033]. The addition of CO2 as the quench fluid shifts equilibrium away from hydrogen to water and carbon monoxide, and the 'reverse shift' is furthered in the *Wang* disclosure by catalysis at unit 26. This is fundamentally different from applicant's claimed invention wherein the water quench, if anything, would result in a lower temperature and higher water content to shift equilibrium toward the production of

hydrogen and CO2, against the very teaching and intent of *Wang* to maximize CO production.

Moreover, the use of water as a primary quench fluid is counterintuitive because, unlike indirect cooling in a boiler to generate steam, for example, it increases the volume of gases that flow through downstream equipment. The offhand disclosure of steam injection in *Wang* at paragraph [0052] is for the limited purpose of gasification of hydrocarbons in the stream, and the skilled artisan would recognize that it would have the disadvantage of shifting equilibrium in Reaction III (see *Wang* at [0032]) away from CO production. Moreover, *quenching* with water is contrary to the aim of *Wang* to produce CO since the resulting lower temperatures and higher water content used in applicant's process disfavor CO production as noted at [0033] in *Wang*: "Reaction (III) is in equilibrium but the position of the equilibrium is pushed far over to the right hand side due to the high temperature of the syngas and the continual introduction of carbon dioxide. Therefore, . . . more carbon dioxide may be converted to useful carbon monoxide."

Conceding that *Wang* does not disclose cooling the POX reactor effluent to 650-1000°C, the office action nonetheless asserts that claim 14 is anticipated by *Wang*, apparently overlooking the affirmative recitation of "means for cooling the first reactor effluent to a temperature from 650° to 1000°C" in claim 14. *Wang*

certainly does not preclude a temperature above 1000°C, and indeed the only temperatures for streams 24 and 26 are disclosed in Table 1 as 1243°C (2269.7°F) and 1196.5°C (2185.7°F). This is consistent with the high temperatures desired for reverse shift equilibrium (see [0032] and [0033]) and CO2 reforming (see [0030] and [0033]). If a difference is found between the claimed invention and the prior art, the claimed invention does not lack novelty and cannot be rejected under 35 U.S.C. 102. See MPEP 2106(VI). The specified cooling means are thus not inherent in *Wang*, and the novelty rejection must be withdrawn as improper.

Moreover, the office action asserts that modification of Wang for cooling to 650° to 1000°C would have been obvious to the skilled artisan "as such a modification is a result effective variable," citing Wang at paragraph [0042], "to control the generated syngas temperature to avoid mechanical integrity problems and improve process operability by reducing the temperature of exothermically generated syngas prior to further processing." Yet *Wang* itself contradicts this asserted modification by disclosing a temperature outside the claimed range of applicant and for the opposite purpose of maximizing CO production, which is diametrically different from applicant's purpose of maximizing hydrogen production. As noted above, Wang discloses that higher temperatures are required to make a far push of the reverse shift equilibrium and for CO2 reforming. See [0030] through [0033]. This is a difference in kind or mode rather than degree

since Wang desires to maximize CO content, whereas applicant desires to increase hydrogen.

The obviousness rejection also overlooks the differences and the criticality of the upper temperature limit of applicant's invention. Applicant discloses that the highest possible temperature is desired, see paragraph [0017] of the specification, but not so high as to result in problematic metallurgical considerations. Applicant further discloses that metal dusting is to be minimized. Metal dusting is understood by the artisan to result from the reaction of carbon in the alloy with the process gas, and since it is a long-term problem that is not readily predicted from process gas composition, alloy composition and/or temperature, and can be discovered to be occurring only after years of operation at the improper temperature, sometimes with disastrous consequences such as tube failure. As such, the temperature claimed is not determinable by routine experimentation using principles of optimization as asserted in the office action, and would not at all have been obvious except from applicant's own disclosure by impermissible hindsight as employed in the rejection.

Applicant has also further distinguished *Wang's* CO production process by emphasizing downstream shift converters in claims 14 and 39. Shift converters are diametrically opposed to the explicit teachings of *Wang* to employ *reverse* shift conversion. The hydrogen/CO distinction is further emphasized in the hydrogen-

favoring operation emphasized in claim 38 and/or the excess water emphasized in claim 40.

The office action also asserts that Wang teaches indirect heat exchange and cross exchange at [0091], however, applicant is unable to find any such disclosure and respectfully traverses. *Wang* here discusses preheating the hydrocarbon/steam feed to the reforming exchanger, not cooling of the reverse shift converter effluent and certainly no cross exchange between these streams. It thus appears that the office action may be confusing the indirect heat/cross exchange with the reforming reactor itself, which is also discussed in the cited passage. New claim language specifying that the indirect heat/cross exchange is upstream from the reforming reactor has been added to clarify this distinction.

The office action also concedes that *Wang* does not teach the 40:60 to 60:40 feed split of applicant, but instead teaches the first and second hydrocarbon portions are supplied in a 68/32 weight ratio. The *Wang* feed split does not exactly translate to applicant's feed split because of the CO2 introduction, which serves as an additional sort of feed stream, but is of course still beyond applicant's claimed split. The disclosed split of the different CO2-quenched process of *Wang* suggests nothing for the split, especially since *Wang* teaches squarely away from applicant's approach and cannot therefore be said to suggest it. There is no motivation or guidance for the optimization of *Wang* for the feed split as asserted in the office

action since Wang clearly desires to increase CO production, not hydrogen; optimization of *Wang* for feed split would thus not obtain applicant's invention.

During the course of these remarks, Applicant has at times referred to particular limitations of the claims which are not shown in the applied prior art. This short-hand approach to discussing the claims should not be construed to mean that the other claimed limitations are not part of the claimed invention. Consequently, when interpreting the claims, each of the claims should be construed as a whole, and patentability determined in light of this required claim construction. Unless Applicant has specifically stated that an amendment was made to distinguish the prior art, it was the intent of the amendment to further clarify and better define the claimed invention.

If the Examiner has any questions or comments regarding this communication, please contact the undersigned directly to expedite the resolution of this application. Further examination of the application, reconsideration of the claims as amended, and the allowance thereof are respectfully requested.

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